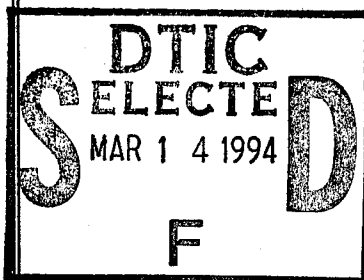


# AOARD REPORT

International Symposium on Advanced Materials, 4th Symposium on High-Performance Materials for Severe Environments, Nagoya, Japan.

June 1993

Capt Paul A. McQuay  
Science Liaison Officer



A summary of the "International Symposium on Advanced Materials, 4th Symposium on High-Performance Materials for Severe Environments," held in Nagoya, Japan, 1-2 June 1993. In addition to this symposium, a second symposium entitled "Japan-Europe Exchange on Composite Materials" was held concurrently. The primary sponsors of the symposia were the Japan Industrial Technology Association (JITA), and the R&D Institute of Metals and Composites for Future Industries (RIMCOF). Both conferences themes centered almost exclusively on advanced structural materials. In addition, some background information on RIMCOF, and the "High-Performance Materials for Severe Environments" project is given herein.

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DTIC QUARTERLY SUMMARY



### Background on RIMCOF

RIMCOF was established in 1981 by the Ministry of International Trade and Industry's (MITI) Agency of Industrial Science and Technology (AIST), under the New Energy and Industrial Technology Development Organization (NEDO). RIMCOF is an incorporated foundation with constitutional assets of ¥51.7 million (\$0.47M, where \$1=¥110), and an annual operating budget of ¥1.7 billion (\$15.5M) for fiscal year 1993. RIMCOF's major operations are from commissioned research and development projects, based on the Industrial Science and Technology Frontier Program planned by AIST. The current objectives of RIMCOF are to pursue "research and development of new metals and composites which have excellent characteristics, and disseminate(e) the achievements, contributing to the promotion and development of industry." To achieve these objectives, RIMCOF is conducting the following major operations (fiscal year 1993):

1. "R&D of High Performance Materials for Severe Environments" program, commissioned by NEDO.
2. Surveys commissioned by the Japan Machinery Foundation:
  - a. Technical trends in advanced new metals and their processing.
  - b. Application of intelligent composite system for aircraft.
  - c. Technical trends in material for space systems.

The management of RIMCOF includes a Board of Directors, with a Chairman and Vice-Chairman from industry, and a full-time Executive Director. In addition, a General Manager, who reports to the Executive Director, oversees three divisions: General Affairs, Metals, and Composites. *Membership in RIMCOF is not restricted to Japanese organizations. US members include Crucible Materials, Pratt & Whitney, and Rohr Industries.*

The current programs sponsored by RIMCOFF are summarized in the next section. Previous projects by RIMCOFF, lasting from 1991 to 1988 were "Advanced Alloys with Controlled Crystalline," and "Advanced Composite Materials." The former project expended approximately ¥4 billion (\$36.4 M). The materials developed on the project were a single-crystal Ni-based superalloy, a superplastic Ni-based superalloy, a superplastic Ti-based alloy, and a particle dispersion strengthened Ni-based superalloy. The later projects budget was approximately the same, and developed fiber reinforced plastic composite materials, and fiber reinforced metal composite materials.

### Symposium Overview

The "International Symposium on Advanced Materials, 4th Symposium on High-Performance Materials for Severe Environments", was held in Nagoya, Japan, 1-2 June 1993. In addition to this symposium, a second symposium entitled "Japan-Europe Exchange on Composite Materials" was held concurrently. Both conferences themes centered almost exclusively on advanced structural materials, with the only exception being a session entitled "Recycling" under the Japan-Europe Exchange.

It should be noted that although the title of the conference claims that it is an "International Symposium," that almost without exception, the only foreign participants were invited speakers whose travel expenses were reimbursed, or local foreigners. This leads to fairly high registration fees for the participants, and also leads to most if not all of the talks to be given in English, in spite of the fact that over 90% of the audience are Japanese. However, the post-presentation questions and discussions are usually not translated into English. This style of meeting is very common in Japan, especially with MITI sponsored functions.

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All of the papers presented at the former symposium are technical status reports of R&D programs sponsored by the R&D Institute of Metals and Composites for Future Industries (RIMCOF). The efforts are part of a national program called "Industrial Science and Technology Frontier Program" formerly known as the "Basic Technologies for Future Industries". Participating in RIMCOF's projects are industry, universities, and government laboratories. Table 1 below lists the current research participants, and the project to which they are contributing.

Table 1. Participants in "R&D of High Performance Materials for Severe Environments"

Laboratory Type	Organization	Project
Corporate	Ishikawajima-Harima Heavy Industries	I
	Ube Industries	C
	Crucible Materials	I
	Kobe Steel	I, C
	Nippon Steel	I, C
	Daido Steel	I
	Nippon Carbon	C
	Hitachi	I
	Fuji Heavy Industries	C
	Mitsui Engineering and Shipbuilding	I
	Mitsubishi Materials	I
	Mitsubishi Heavy Industries	I, C
	Petroleum Energy Center	C
University	Faculty of Technology, University of Tokyo	S
	Faculty of Technology, University of Kyoto	S
	Faculty of Technology, Tohoku University	S
	Institute for Materials, Tohoku University	S
	Faculty of Technology, Osaka Prefectural University	S
Governmental		
	National Research Laboratory of Metrology, AIST	Q
	Mechanical Engineering Laboratory, AIST	I, Q
	Government Industrial Research Institute, Nagoya, AIST	I
	National Institute of Materials and Chemical Research, AIST	C, Q
	Government Industrial Research Institute, Kyushu, AIST	C
	National Research Institute for Metals, Science and Technology Agency	I

I: Intermetallic Compounds; C: Composite Materials; Q: Evaluation Technology;  
S: Fundamental Technology

The current technical themes of the RIMCOF "R&D of High Performance Materials for Severe Environments" program are development of intermetallic compounds and advanced composite materials, and the development of evaluation technology and material evaluation. The two intermetallic compounds currently under study are TiAl, and, while high temperature carbon-carbon composites (C/C), and fiber reinforced intermetallic composites comprise the advanced composite portion of the program. All three research efforts are divided into two phases lasting four years each. The first phase of the programs began in 1989 and is just completed, and the second phase which just began will end in 1996.

In the C/C symposium, one of the speakers acknowledged that the key issue in the development of C/C materials for high temperature applications remains the lack of resistance to oxidation. He also observed that the Japanese C/C community lags approximately 5-10 years behind the US in coating and oxidation resistance technology.

In the area of intermetallic materials, the most interesting work on gamma TiAl in the program remains the isothermal rolling of gamma TiAl sheet. The experimental isothermal mill, which was fabricated for this program by Kobe Steel, has a maximum roll temperature of 1050°C, with an internal preheating unit with a maximum temperature of 1200°C. Although there may be issues associated with the scalability and cost effectiveness of isothermal rolling for TiAl, sheet has been successfully rolled from both single and two phase TiAl, with fairly good results. Also of potential interest is an experimental stirring synthesis process for producing cast gamma TiAl with a fine grain size, being developed by MITI's Mechanical Engineering Laboratory. Most of the work to date has been done on the Cu-Al model system, but the initial work on gamma TiAl looks promising, producing cast grain sizes on the order of 1-3  $\mu\text{m}$ .

The research reported at the conference on Nb-Al intermetallic compounds indicated that although these alloys are less mature than gamma TiAl, considerable progress has been made in ingot and powder processing of Nb<sub>3</sub>Al, as well as alloy development leading to enhanced strength up to 1500°C.

Within the metal-matrix composite symposium, the most notable results were related to developments in new SiC fibers. The most impressive results were from a new fiber developed by Ube Industries called the Tyranno fiber, a Si-Ti-C fiber synthesized from an organometallic polymer. The fiber reportedly has a strength of 2.3 GPa, tested in air at 1500°C. Due to its Ti content, the fiber also has better thermal and chemical stability with Ti alloys. Another new fiber developed by Nippon Carbon, also synthesized from an organometallic polymer, also looks promising for improved high temperature tensile strength and thermal stability.

The major themes of the "Japan-Europe Exchange on Composite Materials" were polymer-matrix composites (PMC), metal and ceramic matrix composites, and recycling. The majority of the papers were presented by authors from Japan, with some authors also from France, the United Kingdom, Belgium, the Netherlands, Denmark and Italy.

The table of contents for both of the conference proceedings are attached. Please contact AOARD if you are interested in receiving a copy of one of these papers.

**次世代先進材料国際シンポジウム**

**INTERNATIONAL SYMPOSIUM ON ADVANCED MATERIALS**

**第4回 超耐環境性先進材料シンポジウム**

**講演集**

**PROCEEDINGS**

**OF**

**THE 4TH SYMPOSIUM ON HIGH-PERFORMANCE  
MATERIALS FOR SEVERE ENVIRONMENTS**

平成5年6月1日(火)～2日(水)

名古屋国際会議場 (白鳥センチュリープラザ)

June 1st (Tue.) to 2nd (Wed.), 1993

Nagoya Congress Center (Shirotori Century Plaza), Nagoya

財団法人 次世代金属・複合材料研究開発協会

財団法人 日本産業技術振興協会

R&D Institute of Metals and Composites for Future Industries (RIMCOF)

Japan Industrial Technology Association (JITA)

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